angiography many admissions to a neurosurgical department for purely diagnostic measures are avoided. With over half our angiograms performed as an out-patient procedure the occupancy of beds by patients not requiring operation is reduced and the volume of operative surgical work increased. Both air encephalography and ventriculography necessitate admission to hospital.

Angiography can provide the early, accurate, and safe diagnosis of emergencies, and that applies particularly to subarachnoid haemorrhage. It is a relatively safe procedure in brain tumours with high intracranial pressure. The benign may be distinguished from the malignant, and in the above series the pathological type of tumour was correctly diagnosed in 39%. Angiography has given us the accurate situation in 74% of brain tumours and in a further 14% has indicated their presence. That compares well with pneumoencephalography. In the remainder the use of ethyl iodophenylundecylate and air as contrast media was necessary.

The mortality of 0.2% has not involved any case of raised intracranial pressure. These cases where the intracranial pressure is extremely high as a result of obstructive hydrocephalus, and mistakenly investigated at first by angiography, are in our experience less disturbed by that and the ethyl iodophenylundecylate ventriculogram that follows than by air ventriculography in the first instance alone.

We wish to thank particularly Mr. R. T. Johnson for his advice and encouragement in the preparation of this paper, and with him Dr. R. G. Reid for making the material available. We are grateful to Sir Geoffrey Jefferson and Dr. E. Duff Gray for their helpful criticisms. To the Department of Medical Illustration under Dr. R. G. W. Ollerenshaw, and to both Mrs. V. Crowley and Mr. E. G. Mercer, we also express our thanks.

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The National Society of Children's Nurseries celebrated its fiftieth anniversary by holding a jubilee conference at County Hall, London, from May 30 to June 1, at which were discussed problems concerning the care, welfare, health, and social problems of children under 5, and the part the nursery can play in giving guidance to parents. There was also a reception at the Mansion House. The conference chairmen included Professor A. A. Moncrieff and Professor R. M. Titmuss, and papers were read by Professor Fraser Brockington ("The Social Background to Child Health in the Mid-twentieth Century"), Professor W. S. Craig ("The Contribution of Nurseries to Child Health in the Home under Conditions of Modern Society"), and Dr. Kenneth Soddy ("The Nursery and the Psychological Needs of the Child"). An important aspect of the society's work has been the training of a large number of young girls so that when they marry they shall be better able to care for their own children.

MATERNAL DEATH FROM ASPIRATION ASPHYXIA

BY

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Recent reports have shown that aspiration of stomach contents during anaesthesia is responsible for a number of maternal deaths in Great Britain (Gilliatt, 1949; Jeffcoate, 1953; Parker, 1954) as well as for a number of near fatalities (Hausmann and Lunt, 1955). Although the incidence of mortality from this cause has been recorded from many centres in the United States of America, there has been no assay of the frequency of the condition in this country, and this report represents an attempt to make good the deficiency.

Birmingham Figures

The figures in Table I refer to women resident in the City of Birmingham, which in the years under review had an average population of approximately 1 million.

TABLE I.—*City of Birmingham*

	Confinements	Domiciliary	Institutional	Deaths, Including Abortion	Anaesthetic Deaths
1943	20,829	11,214	9,615	35	1
1944	23,318	12,196	11,122	31	1
1945	20,685	9,890	10,795	29	1
1946	23,980	11,472	12,508	20	1
1947	25,540	12,225	13,315	24	1
1948	23,067	10,005	13,062	11	1
1949	21,463	9,274	12,189	10	—
1950	19,555	8,492	11,063	16	—
1951	18,850	7,871	10,979	14	2
1952	17,831	7,018	10,813	15	—
Total	215,118	99,657	115,461	205	8 (3·9%)

From 1943 to 1952, inclusive, there were approximately 215,000 confinements and 205 maternal deaths (mortality 0.9 per 1,000 confinements). Included in the 205 deaths are 41 deaths from abortion and 6 due to ectopic gestation; deaths from associated causes are excluded (as with the national figures for England and Wales).

In 8 of the 205 cases (3.9%) I believe death was due, largely or entirely, to aspiration asphyxia, and in two other cases it seems more than possible that aspiration played a major part in the fatal outcome. This represents 1 death for every 27,000 births approximately. The eight deaths occurred in four different hospitals in the city, and summaries of their case histories are presented.

In Cases, 1, 2, 6, 7, and 8 there can be no doubt about the cause of death. In Cases 3, 4, and 5 the reference to anaesthetic difficulty in the records is brief, but, as emphasized before (Parker, 1954), regurgitation may not easily be recognized. *Some* trouble was experienced in the three cases; and in all of them, shortly after conclusion of the anaesthesia, the classical sequence of cyanosis and dyspnoea leading to acute pulmonary oedema was observed. In a previously fit woman with this history there is no alternative diagnosis.

Summary of Case Histories

Case 1.—A primigravida aged 38, in whom it was thought necessary to undertake craniotomy and delivery because of the risk of uterine rupture in an obstructed labour. At

the induction of general anaesthesia she vomited copiously, inhaled vomit, and became deeply cyanosed. The anaesthetic was continued after mopping out the mouth, her condition improved, and the operation was completed one hour after the beginning of anaesthesia. One and a half hours later she again became cyanosed. Despite treatment with intravenous nikethamide her condition deteriorated, and she died four hours after the end of the operation. At necropsy both pleural cavities contained serous fluid, the air passage contained a frothy fluid, and the lungs showed marked oedema and congestion.

Case 2.—A primigravida aged 25. After an inert first stage, forceps delivery was undertaken because of delay in the second stage of labour. She was noted "to take the anaesthetic badly," having a laryngeal spasm, and she vomited, causing a temporary cyanosis. Her general condition at the completion of the third stage was good, but two hours later she suddenly became distressed, cyanosed, and dyspnoeic. The appearances were described as those of "severe circulatory failure" and she died two hours later. At necropsy the trachea and main bronchi contained a large amount of thin greenish exudate. The lungs showed the same material in the bronchi and fairly extensive "areas of collapse."

Case 3.—This patient was admitted as an emergency because of "obstructed labour." She was in her second pregnancy. Under general anaesthesia manual rotation and forceps delivery were successfully completed. She was noted to be cyanosed whilst under the anaesthetic, but her colour improved during the later stages. One hour after ceasing the anaesthetic, cyanosis recurred and frothy sputum was expectorated. Despite treatment with oxygen and digoxin her condition deteriorated rapidly and she died two hours later. No post-mortem examination was made, but the cause of death was stated to be acute pulmonary oedema.

Case 4.—A woman aged 26, in whom, after a prolonged labour, manual rotation and forceps delivery were done under general anaesthesia. She was noted to vomit 1 oz. (28 ml.) during the course of the anaesthesia, but her condition and colour were satisfactory after completion of the third stage. One hour later, having recovered consciousness, she became blue and dyspnoeic. Acute pulmonary oedema was diagnosed and she died six hours later. At necropsy the pleural cavities contained straw-coloured fluid; both lungs showed a considerable amount of frothy fluid on the cut surfaces. No endocardial lesion was found.

Case 5.—A primigravida aged 24, in whom forceps delivery was undertaken after a long incoordinate labour. Ether was "not well tolerated" and she developed a spasmodic cough after return to consciousness. One hour after completion of the operation the obstetrician was summoned to the theatre because of the sudden onset of cyanosis with a rising pulse rate. Pulmonary oedema was diagnosed and death occurred shortly afterwards. Necropsy showed the main bronchi to be completely obstructed by much blood-stained frothy fluid, and the cut surfaces of both lungs also showed the same frothy fluid. The heart was considered to show chronic endocarditis of the mitral valve, though this had not been clinically suspected. *Comment:* It seems probable that aspiration was a major factor in this patient's death, although cardiac disease was present.

Case 6.—A primigravida aged 24, who had a forceps delivery because of delay in the second stage of labour. Vomiting occurred during the early part of the anaesthesia and she was temporarily cyanosed. Her condition was described as satisfactory at the time of delivery, but 15 minutes afterwards she became shocked. The third stage had not then been completed. Blood transfusion and manual removal of the placenta were begun, but though there had been no significant third-stage loss before the placenta was removed the patient died. Necropsy showed the lungs to be moist on the cut surfaces with a considerable amount of frothy fluid. Death was attributed to toxaemia, post-haemorrhagic anaemia, and healed endocarditis. *Comment:* As in Case 5, it is probable that aspiration played a part in this death, though cardiac disease may have hastened the fatal outcome.

Cases 7 and 8 were included as Cases 2 and 5 in a previous series* (Parker, 1954).

Recent Figures

From 1953 to 1955, inclusive, there have been 32 maternal deaths, 2 of which were due to aspiration of vomit. In one case the death was attributed, after necropsy, to this cause. This is the first case in this city in which the anaesthetic has been officially rated as a factor in the cause of death.

National Figures (England and Wales)

Since 1952, all maternal deaths in England and Wales have been subject to investigation by regional assessors, and their findings have been given to the Chief Medical Officer of the Ministry of Health. The latest figures published in his annual report are shown in Table II. From this it can be seen that only 70% of the maternal deaths have been thus assessed. No further information is obtainable, since the reports are confidential, but if it can be taken that there is no selection in the cases reported, it appears that approximately 20 deaths annually (about 4% of maternal deaths) are due to anaesthesia. This would represent 1 death in every 34,000 births approximately. Though it may be guessed that the majority of such cases in this country are associated with general anaesthesia, more exact information on this point is required.

TABLE II.—*Ministry of Health Report*, 1953 (*England and Wales*)

	Maternal Deaths, including Abortion (Registrar-General)	No. of Deaths Assessed	Deaths Due to Anaesthesia
1952	498	371 (74%)	16 (4·3%)
1953	527	341 (65%)	13 (3·8%)
Total	1,025	712 (69·5%)	29 (4·1%)

American Figures

In different centres in the United States maternal mortality from anaesthesia has been related to the total maternal mortality, to the number of anaesthetics administered, and to the number of deliveries in the institutions concerned. (There are, however, as yet no statistics relating to whole communities in the United States: J. P. Greenhill, personal communication.) Conditions differ in various hospitals, there as here, and their results can only be applied warily to this country. In interpreting their figures the following points must be borne in mind. Over four million births occur annually in the United States, of which more than 90% take place in hospital. Hingson and Hellman (1951) state that over three million obstetric cases receive some form of anaesthesia annually. This estimate may seem high, but there are many institutions, such as the Chicago Lying-In (Greenhill), where almost 100% of the patients receive an anaesthetic, inhalational or topical, for delivery. It is unfortunately impossible to ascertain, from any report, the incidence of the administration of different types of anaesthesia, and without this vital information the bare record of the number of deaths attributed to each method is of limited value. Bearing this in mind, I have extracted the following data.

Dieckmann (1945) noted that among 46,000 obstetric patients given inhalational anaesthesia in the Chicago Lying-In Hospital aspiration of vomit occurred 45 times (1 in 1,000) and there were two deaths (1 in 23,000 anaesthetics). Gordon (1947), reporting on 958 maternal deaths, found that 43 (4.5%) were due to anaesthesia (all forms), 14 of them (1.5%) to aspiration of vomit. Merrill and Hingson (1951), in a report covering the five-year period 1945–9 at 183 different hospitals, found that there were 59 deaths due to inhalation of vomit in approximately 2½ million births

*The other three fatal cases described in that series were women not resident in the city, and were therefore excluded from the present study.

(1 in 42,000 births). They therefore estimated that there might be up to 100 deaths annually in the U.S.A. from this cause. In this last series, deaths from aspiration accounted for 1.5% of the maternal mortality. Klein *et al.* (1953) found that 22 (5.3%) of 413 maternal deaths were due to anaesthesia, and of this number 7 (1.7%) were due to aspiration asphyxia. Further, they noted that as other causes of death became rarer with the passage of time the incidence of anaesthetic deaths was mounting.

An occasional report gives more alarming figures. Hartnett (1953) states that anaesthesia was responsible for 11 out of a total of 25 maternal deaths in four St. Louis hospitals over a five-year period. Moreover, he points out that in only 3 of the 11 was the anaesthetic specifically mentioned in the records as a factor in the cause of death. He therefore suggests that official records may be misleading by underestimating the size of the problem. This same point has repeatedly been made by Gordon *et al.* (1955), who believe that death due to anaesthesia is much commoner than most official figures would suggest. Ott and Byrd (1955) state that they believe that 10% of all the maternal deaths in the State of Michigan are now due to anaesthesia.

From this wealth of American data the main facts to note are that fatalities occur with spinal, intravenous, and inhalational anaesthetics, accounting for from 2 to 10% of all maternal deaths; aspiration of vomit is responsible for one-third to one-half of the anaesthetic deaths in the United States; and as other causes of mortality diminish in frequency deaths from anaesthesia show no such trend.

Domiciliary Midwifery in Birmingham

Table I shows that almost 100,000 confinements took place between 1943 and 1952 in the patients' homes. During that time 3,048 forceps deliveries were performed without a death from aspiration of vomit. It can safely be stated that most if not all of these operations were performed under general anaesthesia, usually chloroform and ether on open mask. From questioning practitioners in the city, it is known that both the dorsal and the lateral position were used for delivery, though in what exact proportions is not known. In most if not all cases no stomach tube was passed and there was no sucker available. Yet during the time that those 3,048 forceps deliveries were performed safely in the home, 2,200 deliveries were done in the Birmingham Maternity Hospital with four deaths due to aspiration. It was the apparent discrepancy in these figures which prompted the present report. In defence of the hospitals, it might be said that their cases include the greater risks, thereby accounting for the difference. But it is well recognized that aspiration asphyxia can and does attack the healthy woman as well as the unfit. The latter group, of course, will include more fatalities, since their powers of recovery are limited, but most series of cases include perfectly fit women.

It should be noted, incidentally, that the number of forceps deliveries carried out at home in this city has shown a progressive yearly decline from 572 in 1943 to 50 in 1954.

Prevention of Disaster

Much has been written concerning the prevention of aspiration in obstetric cases, and much interest has been roused by Morley's (1955) forthright criticisms of the lithotomy position for delivery. It is felt that the following points are worthy of particular emphasis.

Local Analgesia.—Extension of the use of local infiltration analgesia can greatly reduce the call for emergency inhalational anaesthetics. At the Birmingham Maternity Hospital from July, 1954, to June, 1955, inclusive, 140 out of a total of 233 forceps deliveries (60%) were performed under local analgesia without mortality. (A few years previously local analgesia accounted for less than 10%.) The same percentage is reported by Gate and Dutton (1955). The risks due to this procedure are two. Firstly, several cases of overdosage have now been reported, though no fatality has occurred in Britain, and the limits suggested by Rollason (1955) should be observed. The second hazard is the formation of a vulval haematoma from needle laceration of a deep vein. Two such haematomas occurred in the Birmingham series. But the incidence of trouble is so small that pudendal block analgesia appears to be much safer than any other method available for forceps delivery.

Delivery Table.—When general anaesthesia is required it is desirable that the anaesthetist should be allowed to work in conditions which he regards as safe. No obstetric delivery bed of which I am aware gives conditions equal to an operating-table in respect of easy rapid tilting in both directions. For emergency operations the technique advised (for the expert) by Morton and Wylie (1951) involves a foot-down tilt for induction and the passage of a cuffed endotracheal tube. These conditions should be available for general anaesthesia for forceps delivery, and only the tradition that such deliveries should be undertaken in a bed (rather than in comfort on an operating-table) appears to prevent it. When local analgesia is used the delivery can of course be performed safely on any bed.

Lateral Position.—Most obstetricians prefer to perform operative vaginal deliveries in the lithotomy position. But O'Mullane (1954) has shown that a considerable increase in intragastric pressure occurs on assuming that position. He has further demonstrated that regurgitation readily occurs if the airway is obstructed during inspiration. There is no doubt, therefore, that Morley's (1955) criticisms of the lithotomy position are well founded, except where adequate precautions are taken to prevent aspiration. A suspicion remains, however, that the assumption of the lithotomy position is not in itself so dangerous a step as hospital figures would lead us to believe. A common practice in using forceps in the home is to harness the patient in the lithotomy position and to give open-mask anaesthesia. From this seemingly "dangerous" practice no fatality has occurred in recent years in Birmingham (or in two other large cities, the records of which I have examined). Williams (1956) has come to the conclusion that the lithotomy position, *per se,* is not the factor responsible for death from aspiration. Wylie (1955) mentions the occurrence of deaths in the home but does not state whether "open" anaesthesia is responsible. National figures if and when available will perhaps be of help in resolving this important question.

Anaesthetic Machine.—If it is true that the hazard of aspiration is greater in hospital than in the home, then suspicion must rest upon hospital methods. Most recorded cases in Birmingham have received nitrous oxide, oxygen, and ether, and the responsible agent might therefore be the anaesthetic machine. A non-transparent face-piece will undoubtedly hinder the early recognition of silent regurgitation; but, in addition, could not the pressure of gas which can be built up against the closed glottis in a semi-closed circuit be of importance in the subsequent aspiration of relatively large volumes of fluid stomach contents from the pharynx? Certainly quite high pressure can be built up if the expiratory valve is inadvertently kept closed. It is noteworthy that Lock and Greiss (1955) in their recommendations again underline the importance of not "forcing" the anaesthetic when retching occurs. Whatever the mechanism of major aspiration, there is now some reason to think that the unskilled occasional anaesthetist might be wise to choose the open mask in preference to the Boyle machine for anaesthetizing women in labour. This does not, of course, absolve him from taking every additional precaution to avoid aspiration.

Comment

Anaesthesia is at present low in the list of causes of maternal death in Britain. But because such deaths are entirely preventable, and because the victim is often a perfectly fit woman, it has an importance greater than its lowly place might suggest.

It is probable that the skilled anaesthetist can invariably avoid disaster, as is shown by the recent series of 18,648 obstetric anaesthesias without a death by Lock and Greiss

(1955). But by the very nature of obstetric work it is unlikely that the services of a skilled anaesthetist can be always and everywhere available. In America, Greenhill and Gordon have both made repeated outspoken criticisms of the anaesthetic service available for obstetric patients. Gordon (1952) has said: "I don't think there are half a dozen places in the United States where an obstetrician can get, at any time, day or night, the anaesthetic he likes." Recently in Britain, Wrigley (1955) has commented, "In hospital, too often the administration of anaesthetics to women in labour is left in the hands of the most junior member of the anaesthetic team." Undoubtedly, the anaesthetic service to obstetric units in this country is improving rapidly, but for a long time to come it must be expected that some obstetric anaesthetics will have to be administered by the unsupervised trainee-anaesthetist or a fellow obstetric officer or practitioner. Therefore any recommendations concerning anaesthesia for forceps delivery must take this state of affairs into account.

Local analgesia is best for simple forceps delivery, chiefly because it avoids the greater risks of the other methods, but also because it allows the mother to be present at the birth of her baby; further, it can have no adverse effects upon the baby. But it is unlikely that more than 60% of assisted deliveries can be done under local analgesia.

When general anaesthesia is to be used it seems likely that the expert and the experienced trainee will wish to use an endotracheal tube, and it is part of the purpose of writing this to plead that anaesthetists be given working conditions in the labour theatre equal to those obtaining in a modern surgical theatre. In most obstetric units that implies the use of a surgical table for delivery, *whether it be by forceps or caesarean section.*

When a general anaesthetic is to be given by someone with no special training, a safe technique is that described by Morton and Wylie (1951), using the Boyle machine, which involves continuous suction on a wide-bore stomach tube throughout the administration. This technique is not popular, and if it is not to be used the Birmingham figures suggest that it *may* be as safe to use the open mask. That the latter is not entirely safe is apparent from a study of the maternal deaths reported by Lock and Greiss (1955), several of which were associated with open ether. Yet the feeling remains that it would often be safer than the handling of a machine by an inexpert practitioner. Under such conditions there can be little doubt that the lateral position advocated by Morley (1955) offers an additional factor for anaesthetic safety, though it may on occasion add to the obstetric difficulties. Certainly it would be difficult now to defend the use of the machine (in the absence of a cuffed endotracheal tube) for a patient whose stomach was not certainly empty and who was to be delivered in the lithotomy position in a bed.

These observations are important in relation to undergraduate teaching. The necessity of training every medical student to "anaesthetize competently" for a forceps operation or breech delivery has recently been noted (*British Medical Journal*, 1956); but there is still no unanimous opinion on what technique he is to be taught to use.

Summary

In the City of Birmingham death from aspiration of vomit has accounted for 4% of maternal mortality in recent years.

National figures appear to confirm this estimate of its frequency.

All Birmingham deaths from aspiration have occurred in hospital.

Over 3,000 forceps deliveries have been performed in domiciliary practice in the city without any such mortality. It is suggested that the anaesthetic machine (in other than skilled hands) may be less safe than the open mask.

Progress with the use of local analgesia for forceps delivery from one hospital is reported. At present 60% of forceps deliveries are done without a general anaesthetic.

I owe thanks to Dr. Jean M. Mackintosh, Medical Officer of Health for Maternity and Child Welfare, for allowing me to study her complete records of maternal deaths in the City of Birmingham; I am grateful to Dr. Eileen Ring, of the same department, for the help she has given me. My thanks are also due to the many practitioners in the city who answered my queries and to the hospital consultants who allowed me to publish my summaries of their case records and the figures from the Birmingham Maternity Hospital.

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INCIDENCE OF TONSILLECTOMY, CIRCUMCISION, AND APPENDICECTOMY AMONG R.A.F. RECRUITS

BY

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Whilst doing my national service in the R.A.F. I decided to take the opportunity afforded by the routine examination of recruits of analysing the incidence of tonsillectomy, circumcision, and appendicectomy in Great Britain. Though these are probably the most commonly performed operations, only in the case of circumcision has there previously been a survey of the incidence in the whole country. Inspired by Gairdner (1949), MacCarthy *et al.* (1952) analysed the incidence of this operation in a national sample of 4-year-olds.

All tonsillectomies performed under the aegis of the local education authorities in England and Wales are notified to the Chief Medical Officer of the Ministry of Education. In his biennial report to the Minister, the Chief Medical Officer records the total number of such operations performed each year. These figures apply only to children of school age (5 to 14) attending Government-maintained and assisted schools. Glover (1950) has analysed these returns and commented on the large number of tonsillectomies performed.

Moloney *et al.* (1950) have recorded the number of cases of acute appendicitis occurring in the Oxford area between 1945 and 1948, and from them estimated the number of cases in Great Britain each year.